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(54) MAGNETIC RECORDING MEDIUM

(57)Abstract:
PROBLEM TO BE SOLVED: To inexpensively provide a perpendicular magnetic recording medium on which high density recording can be performed.
SOLUTION: The magnetic recording medium is characterized in that a first magnetic layer constituted of a ferromagnetic metal alloy containing cobalt and a non-magnetic metal oxide and a second magnetic layer consisting of a rare earth-transition metal alloy are laminated in this order on at least one surface of a substrate.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]Especially this invention relates to the perpendicular magnetic recording medium in which high-density magnetic recording is possible about magnetic recording media, such as magnetic tape, a flexible disk, and a hard disk.
[0002]
[Description of the Prior Art]In recent years, although the personal computer is equipped with the large hard disk corresponding to the handling of the mass picture information by the spread of the Internet etc., the needs of preservation of moving image information are great, and this hard disk drive requires high-capacity-izing and low-pricing further. In order to back up a lot of information accumulated in this hard disk or to use by other computers, the recording medium of various kinds of removable types is used. It has many features, like the flexible magnetic recording medium of magnetic tape, a flexible

disk, etc. is small, and also has a device which the time which record of information and read-out take like a hard disk is short, and needs it for record of information, and read-out. For this reason, magnetic tape and a flexible disk are used for backup of a computer, and preservation of a lot of data as a typical removable type recording medium. And the magnetic recording medium which can save a lot of data is called for with the magnetic tape of the small number, and a flexible disk, and the further improvement in storage density is called for.

[0003]For this reason, the perpendicular magnetic recording it is supposed that is excelled in the high density recording characteristic attracts attention, and various recording methods, the magnetic head, and the magnetic recording medium are proposed. However, in order to be a perpendicular magnetic recording medium which uses the conventional CoCr alloy and a CoCrPt alloy as a magnetic layer and to attain still higher surface recording density. Although record film thickness must be 30 nm or less for low-noise-izing, when the problem of what is called "heat fluctuation" that magnetization is lost with the heat about a room temperature puts in practical use in ****, with such a super-thin film, it poses a big problem. Although high perpendicular magnetic anisotropy is shown on the other hand and rare earth transition metals [, such as Co system multilayer film and TbFeCo,], such as Co/Pd and Co/Pt, are known as a material strengthened to heat fluctuation, In such a magnetic material, there was a problem that the switched connection of field inboard was strong and a noise was higher than the conventional CoCrPt system alloy. The medium (called a hybrid medium or a CGC medium) which recently laminates a CoCrPt system vertical magnetic memory film, the above-mentioned Co system multilayer film, and rare earth transition metal record film as the technique of controlling the switched connection and perpendicular magnetic anisotropy within a field is proposed to these SUBJECT.

[0004]Since it is necessary to make substrate temperature into a room temperature when heating substrate temperature at not less than 200 ** when forming a CoCrPt system alloy by such a hybrid medium, and forming Co system multilayer film and the rare earth transition metal on it, A cooling process is required between stage film formation two-layer [these], and productivity had SUBJECT. When it was going to use the flexible medium and polycarbonate board which use a high polymer substrate as a nonmagnetic substrate, since it was able to come and the high polymer substrate of ** and others changed, a recording medium was not able to be produced with the substrate temperature which forms a CoCrPt system alloy.

[0005]

[Problem(s) to be Solved by the Invention]This invention makes it SUBJECT to provide cheaply the perpendicular magnetic recording medium in which high density recording is possible. It carries out providing a useful magnetic recording medium to magnetic tape, a flexible disk, etc. which can be used as a removable type magnetic recording medium with SUBJECT.

[0006]

[Means for Solving the Problem]SUBJECT of this invention is solved by a magnetic recording medium laminating a ferromagnetic metal alloy which contains cobalt in at least one field of a base material, the first magnetic layer that comprised a non-magnetic metal oxide, and the second magnetic layer that consists of a rare earth transition metal in this order.

[0007]
[Embodiment of the Invention]The magnetic recording medium of this invention is a magnetic recording medium laminating the ferromagnetic metal alloy which contains cobalt in at least one field of a base material, the first magnetic layer that comprised a non-magnetic metal oxide, and the second magnetic layer that consists of a rare earth transition metal in this order. The ferromagnetic metal alloy containing cobalt, and the magnetic layer which comprised a non-magnetic metal oxide, since forming by sputtering process etc. is possible even if the temperature of a base material is a room temperature, the process of substrate cooling required before forming the rare earth transition metal which forms membranes on it succeedingly is skipped -- things can be carried out. Even if it is a case where polymeric support, such as polycarbonate and polyethylenenaphthalate, is used as a substrate as a base material, there is no substrate deformation by heat and the magnetic recording medium excellent in the recording characteristic can be manufactured.
[0008]With reference to Drawings, this invention is explained below. Drawing 1 is a figure showing one working example of this invention, and is a sectional view. As for the magnetic recording medium 1, the ferromagnetic metal alloy containing cobalt, the first magnetic layer 3A that comprised a non-magnetic metal oxide, and the second magnetic layer 3B that consists of a rare earth transition metal are formed on the base material 2. or [wear on the magnetic layer 3 which consists of the magnetic layer 3A and the magnetic layer 3B, prevent degradation by oxidation of a magnetic layer, etc., and according to contact with a head or a slide member] -- from -- the protective layer 4 to protect is formed. On the protective layer 4, the lubricating layer 5 is formed in order to improve running durability, corrosion resistance, etc.
[0009]In the above-mentioned lamination, while adjusting the surface nature of the base material 2 between the magnetic layer 3A and the base material 2, in order to prevent the gas produced from the base material 2 from reaching the magnetic layer 3A etc., an under coat may be provided on the base material 2. And the foundation layer for controlling the crystal orientation of the ferromagnetic metal further formed in the magnetic layer 3A, and improving a recording characteristic may be provided between an under coat and the magnetic layer 3A, the crystal orientation of ferromagnetic metal becomes good by a foundation layer, and what was more excellent in the characteristic compared with what was shown in drawing 1 is obtained. When a magnetic recording medium is magnetic tape, the layer of the above-mentioned composition is provided in one side, and although stored in the open reel or the cartridge, it can usually use with which gestalt. When a magnetic recording medium is a flexible disk, the layer of the above-mentioned composition is provided in both sides of a base material, and the central part is usually equipped with the engagement means for equipping a flexible disk drive. When a magnetic recording medium is a hard disk, the glass substrate in which the surface polish of the base material was carried out is usually used. The central part is equipped with the engagement means for equipping a disk drive. A backing layer is provided in order to improve the vertical magnetic memory characteristic at the time of using a single magnetic pole head.
[0010]Since the magnetic layer formed in the magnetic recording medium of this invention is provided with the ferromagnetic metal alloy containing cobalt, the first magnetic layer that comprised a non-magnetic metal oxide, and the second magnetic

layer that consists of a rare earth transition metal, High recording density record is attained like the conventional CoCrPt system alloy thin film magnetic layer, and reducing heat fluctuation substantially further cuts. Since [which forms a magnetic layer with the substrate temperature of a room temperature] things can be carried out, the medium which combined the conventional CoCrPt system alloy magnetic layer, and this and a rare earth transition metal is excelled in productivity. High capacity-ization of the removable type magnetic recording medium which furthermore forms a base material by a high polymer substrate is attained. The ferromagnetic metallic thin film which consists of a ferromagnetic metal alloy containing this cobalt and a non-magnetic metal oxide can use the thing which is proposed with the hard disk and which is indicated to JP,H5-73880,A, JP,H7-311929,A, etc., and the thing manufactured by the same method.

[0011]The magnetic layer in the magnetic recording medium of this invention is what is called a vertical magnetic memory film that has an easy axis perpendicularly to a magnetic layer side. The direction of this easy axis is controllable by the material of a foundation layer, a crystal structure, and a presentation and film formation condition of a magnetic film.

[0012]The ferromagnetic metal alloy containing cobalt in this invention, and the first magnetic layer that comprised a non-magnetic metal oxide, While being able to attain high coercive force even if it does not heat a substrate since the detailed ferromagnetic metal alloy crystal is distributing uniformly, as a result of dispersibility's becoming uniform, the small magnetic recording medium of a noise can be obtained. Since it has the second magnetic layer that consists of a rare earth transition metal with high perpendicular magnetic anisotropy on it, it is strong to heat fluctuation and the magnetic recording information recorded once can be held over a long period of time. Although the alloy of Co and elements, such as Cr, nickel, Fe, Pt, B, Si, and Ta, can be used as a ferromagnetic metal alloy containing cobalt, since the magnetic-recording characteristic has Co-Pt, Co-Cr, Co-Pt-Cr, Co-Pt-Cr-Ta, good Co-Pt-Cr-B, etc., it is desirable.

[0013]For example, as desirable elementary composition of the CoPtCr system alloy used for vertical recording, the presentation as which 65-80atom% is chosen as for Co, and 5-20atom% and Cr are chosen from the range of 10-20 atom % for Pt is mentioned. What is necessary is just to add so that Pt or Cr may be replaced in the range below ten atom % in adding nonmagnetic elements, such as B and Ta, to this. Magnetization becomes large, and the reproducing output of a signal increases so that there is much content of Co, but a noise also increases simultaneously. On the other hand, magnetization becomes small so that there is much content of nonmagnetic elements, such as Cr and Pt, but since coercive force increases, although the reproducing output of a signal decreases, a noise decreases. Therefore, it is preferred to adjust the rate of a compounding ratio of these elements according to the magnetic head and use device to be used.

[0014]The anisotropy of magnetization can be adjusted with conditions, such as argon pressure at the time of membrane formation besides a presentation, and it is dependent also on the kind of the below-mentioned foundation layer. When the case where a foundation layer is not used, and an amorphous material are used, it is easy to carry out orientation of the magnetic layer vertically, but when Cr or its alloy, Ru, or its alloy is used, an in-plane orientation may be carried out, and it is used as a field inner magnet mind recording medium.

[0015]Although oxides, such as Si, Zr, Ta, B, Ti, and aluminum, can be used as a non-

magnetic metal oxide, the thing of a recording characteristic using the oxide of silicon is the best.
[0016]As for the mixture ratio of the ferromagnetic metal alloy and non-magnetic metal oxide containing cobalt, it is preferred that it is the range of ferromagnetic metal alloy:non-magnetic metal oxide =95:5 - 80:20 (metal atom ratio), and it is preferred that it is especially the range of 90:10-85:15. Since separation between magnetic particles becomes enough, coercive force does not decline and a magnetization amount can also be highly maintained by considering it as such a range, a high signal output is obtained.
[0017]10 nm - 60 nm are the ranges of 20 nm - 30 nm still more preferably preferably as thickness of the first magnetic layer that consists of a mixture of the ferromagnetic metal alloy and non-magnetic metal oxide containing cobalt. If it is considered as such thickness, a medium with a low noise will be obtained.
[0018]As a method of forming the first magnetic layer that consists of a ferromagnetic metal alloy containing cobalt, and a non-magnetic metal oxide, vacuum film formation method, such as a vacuum deposition method and sputtering process, can be used. Since a good thin film can form membranes easily, sputtering process is especially suitable for this invention. As sputtering process, it is usable in both a DC sputtering method and RF sputtering process. As for sputtering process, when it is going to manufacture magnetic tape and a flexible disk, it is preferred to use the web sputtering system which continues on a continuation film and forms membranes. Although the gas used for the atmosphere at the time of sputtering can use argon, other rare gas may be used. In order to adjust the oxygen content of a non-magnetic metal oxide, a small amount of oxygen may be introduced.
[0019]In order to form the ferromagnetic metal alloy which contains cobalt by sputtering process, and the magnetic layer which consists of a non-magnetic metal oxide, it is also possible to use these ** sputtering process using two sorts, a ferromagnetic metal alloy target and a non-magnetic metal oxide target, but. If the mixture target which mixed the non-magnetic metal oxide with the ferromagnetic metal alloy which should be formed, and the ferromagnetic metal alloy corresponding to the composition ratio of the non-magnetic metal oxide homogeneously is used, the magnetic layer which the ferromagnetic metal alloy distributed uniformly can be formed. This mixture target is producible by hot pressing.
[0020]The rare earth transition metal formed as the second magnetic layer refers to the alloy containing a rare earth metal and a transition metal. The alloy which contains at least one sort of rare earth metals chosen from a terbium, gadolinium, neodium, and dysprosium and at least one transition metal of iron and cobalt as a rare earth transition metal is preferred. The alloy which contains also in this a terbium, iron, the alloy that contains cobalt as the main ingredients and dysprosium, iron, and cobalt as the main ingredients is more preferred, and a terbium, iron, and especially the alloy that contains cobalt as the main ingredients are preferred.
[0021]The magnetic properties of a rare earth transition metal are mainly determined by the composition ratio of a rare earth metal and a transition metal. For example, when it contains a terbium as a rare earth metal, the alloy whose content of a terbium is 14-20atom% is more preferred. By making content of a terbium into the range of 14-20 atom %, coercive force of the perpendicular direction of a magnetic layer can be made into the range of 1500Oe suitable for vertical magnetic memory - 6000Oe (**120 - 480 kA/m).

As for the saturation magnetization of a magnetic layer, 50 to 800 emu/cc (**0.063-1.0Wb/m^2) is preferred, and 100 to 400 emu/its cc (**0.13-0.50Wb/m^2) is still more preferred. It is preferred that the coercive force of the magnetic recording medium which laminated the first magnetic layer and the second magnetic layer is 2000Oe - 6000Oe (**160 - 480 kA/m), and saturation magnetization is 50 - 800 A-m^2 / kg (**0.063-1.0Wb/m^2).

[0022]The rare earth transition metal may contain either [at least] chromium or nickel further. Corrosion resistance improves by containing chromium and nickel. As a method of forming the second magnetic layer that consists of a rare earth transition metal, vacuum film formation method, such as a vacuum deposition method and sputtering process, can be used. Since a good thin film can form membranes easily, sputtering process is especially suitable for this invention. As sputtering process, it is usable in both a DC sputtering method and RF sputtering process. As for sputtering process, when it is going to manufacture magnetic tape and a flexible disk, it is preferred to use the web sputtering system which continues on a continuation film and forms membranes. Although the gas used for the atmosphere at the time of sputtering can use argon, other rare gas may be used. In order to form the second magnetic layer of a rare earth transition metal by sputtering process, it is also possible to use these ** sputtering process using two sorts of targets, a rare earth metal and a transition metal, but. If the mixture target which mixed homogeneously the rare earth metal corresponding to the composition ratio of the rare earth transition metal which should be formed, and the transition metal is used, the magnetic layer which the rare earth transition metal distributed uniformly can be formed.

[0023]The case where a magnetic recording medium is magnetic tape is explained below. A synthetic resin film is used as flexible support used for magnetic tape. Specifically Aromatic polyimide, aromatic polyamide, aromatic polyamidoimide, Polyether ketone, polyether sulphone, polyether imide, The synthetic resin film which consists of polysulfone, a polyphenylene sulfide, polyethylenenaphthalate, polyethylene terephthalate, polycarbonate, triacetate cellulose, a fluoro-resin, etc. is mentioned. Since a good recording characteristic can be attained without heating a substrate in this invention, especially polyethylene terephthalate or polyethylenenaphthalate also for acquisition with surface nature easy good is preferred.

[0024]3-20 micrometers of thickness of flexible polymeric support are 4 micrometers - 12 micrometers still more preferably preferably. If the thickness of flexible polymeric support is thinner than 3 micrometers, intensity will run short and it will become easy to generate cutting and an edge crease. On the other hand, if the thickness of flexible polymeric support is thicker than 20 micrometers, the magnetic tape length which can roll round to per magnetic tape will decrease, and volume storage density will fall. Since rigidity becomes high, it gets worse, the hit, i.e., the flattery nature, to a magnetic head.

[0025]In order to contact a magnetic head and to perform record and read-out of information, the thing smooth as much as possible of the surface of flexible polymeric support is preferred. Unevenness of the flexible Polymer Division support surface reduces the recording reproduction characteristics of a signal remarkably. When specifically using the under coat mentioned later, less than 1 micrometer of projected height which less than 5 nm of surface roughness measured with the light interference-type surface roughness plan usually measured with less than 2 nm and a sensing pin type

roughness gauge preferably by the longitudinal-plane-of-symmetry average of roughness height (SRa) is usually less than 0.1 micrometer preferably. Less than 0.1 micrometer of projected height which less than 3 nm of surface roughness measured with the light interference-type surface roughness plan usually measured with less than 1 nm and a sensing pin type roughness gauge preferably in the case where an under coat is not used at the longitudinal-plane-of-symmetry average of roughness height (SRa) is usually less than 0.06 micrometer preferably.

[0026]It is preferred to provide an under coat in the flexible Polymer Division support surface an improvement of smoothness and for the purpose of gas barrier properties. Since a magnetic layer is formed by sputtering etc., as for an under coat, excelling in heat resistance is preferred, and it can use polyimide resin, polyamide imide resin, silicone resin, a fluoro-resin, etc. as a material of an under coat, for example. Solvent meltable type polyimide resin, heat-hardened type polyimide resin, and heat-hardened type silicone resin have an especially highly preferred flattening effect. As for the thickness of an under coat, 0.1 micrometer - 3.0 micrometers are preferred. The silicone resin which polymerized in the sol gel process as thermosetting silicone resin by using as a raw material the silicon compound in which the organic group was introduced is used suitably. Since this silicone resin consists of structure which replaced a part of combination of the silica dioxide by the organic group, and is more nearly substantially [than silicone rubber] excellent in heat resistance and it excels a silica dioxide film in pliability, even if it forms a resin layer on the polymeric support which consists of flexible films, neither a crack nor exfoliation produces it easily. The monomer used as a raw material can be directly applied on flexible polymeric support, and can be stiffened. And since a monomer can be dissolved in a common organic solvent and it can apply to it, the surroundings lump which receives unevenness is also good and a flattening effect is high. Since a polycondensation reaction advances from low temperature comparatively by addition of catalysts, such as acid and a chelating agent, it can be stiffened in a short time and can form a resin layer using a general-purpose coater. Thermosetting silicone resin is excellent in gas barrier properties. For this reason, the gas cover nature which covers the gas which occurs from flexible polymeric support at the time of a magnetic layer or foundation layer formation, and checks the crystallinity of a magnetic layer or a foundation layer and a stacking tendency is high, and especially preferred.

[0027]It is preferred to provide a minute projection (texture) for the purpose of reducing the real contact area of slide members, such as a magnetic head and a guide pole, and magnetic tape, and improving a sliding characteristic on the surface of an under coat. The handling nature of flexible polymeric support also becomes good by providing a minute projection. Although the method of applying spherical silica particles, the method of applying an emulsion and forming the projection of an organic matter, etc. can be used as a method of forming a minute projection, in order to secure the heat resistance of an under coat, it is preferred to apply spherical silica particles and to form a minute projection.

[0028]As for the height of a minute projection, 5 nm - 60 nm are preferred, and its l0nm-30mm is more preferred. If the height of a minute projection is too high, the recording reproduction characteristics of a signal will deteriorate by the spacing loss of a record reproduction head and a magnetic recording medium, and if a minute projection is too low, the improvement effect of a sliding characteristic will decrease. As for the density of

a minute projection, two are preferred in 0.1-100 pieces/micrometer, and two are more preferred in 1-10 pieces/micrometer. When there is too little density of a minute projection, the improvement effect of a sliding characteristic decreases, if too large, by the increase in floc, a high projection will increase and recording reproduction characteristics will deteriorate. A minute projection is also fixable to a support surface using a binder. It is preferred to use the resin which equipped the binder with sufficient heat resistance, and especially the thing for which solvent meltable type polyimide resin, heat-hardened type polyimide resin, and heat-hardened type silicon resin are used is preferred as resin provided with heat resistance.

[0029]In the lower layer of a magnetic layer, it is preferred to provide a foundation layer. Nitrides, such as amorphous materials, such as an alloy which makes a subject metal or these metal, such as Ti, Pt, Ru, and Pd, as a foundation layer, or C, Si, aluminum, and Ti, an oxide, etc. can be raised. Since the stacking tendency and granulation of a magnetic layer are improvable by using such a foundation layer, a recording characteristic improves. As for the thickness of a foundation layer, 10 nm - 200 nm are preferred, and 20 nm - especially 100 nm are preferred. Especially the thing in which the magnetic layer was formed pillar-shaped of the foundation layer is preferred. By being formed pillar-shaped, the isolation construction between ferromagnetic metal is stabilized, high coercive force is acquired, and high power becomes possible, and distribution of ferromagnetic metal will become uniform, and the magnetic recording medium of a low noise will be obtained.

[0030]Between a foundation layer and flexible polymeric support, in order to improve the adhesion and structure of a foundation layer, a seed layer can be provided. Ta, Ta-Si, nickel-P, nickel-aluminum, etc. can be used for a seed layer.

[0031]When performing the vertical magnetic memory by a single magnetic pole head, it is preferred to provide a soft magnetism layer between a magnetic layer and flexible polymeric support. A magnetic parametric performance can be improved by providing a soft magnetism layer. Materials, such as a permalloy and Sendust, can be used as soft magnetic materials. It is preferred that it is 30-200 nm as the thickness.

[0032]A protective layer is provided on a magnetic layer. A protective layer prevents the corrosion of the metallic material included in a magnetic layer, prevents the false contact with a magnetic head and magnetic tape, or wear by contact sliding, and it is provided in order to improve running durability and corrosion resistance. In a protective layer, silica, alumina, a titania, zirconia, cobalt oxide, Materials, such as carbon, such as carbide, such as nitrides, such as oxides, such as nickel oxide, titanium nitride, silicon nitride, and boron nitride, silicon carbide, chromium carbide, and boron carbide, graphite, and amorphous carbon, can be used.

[0033]It is a rigid film which is equivalent to magnetic head construction material, or has the hardness beyond it as a protective layer, and what the effect is stabilized and is maintained that it is hard to produce seizure during sliding is excellent in sliding durability, and preferred. What has a few pinhole is excellent in corrosion resistance, and simultaneously more preferred. The hard carbon film called the diamond like carbon (DLC) produced with a CVD method as such a protective film is mentioned. A protective layer can be considered as the composition which laminated two or more kinds of thin films in which character differs. For example, it becomes possible by providing the hard carbon protective film for improving a sliding characteristic in the surface side, and

providing nitride protective films, such as silicon nitride for improving corrosion resistance to the magnetic layer side, to be compatible at a high dimension in corrosion resistance and endurance.

[0034]On a protective layer, in order to improve running durability and corrosion resistance, a lubricating layer is provided. Lubricant, such as hydrocarbon system lubricant, fluorine system lubricant, and an extreme pressure additive, is used for a lubricating layer. As hydrocarbon system lubricant, carboxylic acid, such as stearic acid and oleic acid. Sulfonic acid, such as ester species, such as butyl stearate, and octadecylsulfonic acid. Amines, such as carboxylic amide, such as alcohols, such as phosphoric ester, such as phosphoric acid monooctadecyl, stearyl alcohol, and oleyl alcohol, and octadecanamide, and stearylamine, etc. are mentioned.

[0035]As fluorine system lubricant, the lubricant which replaced a part or all of the alkyl group of the above-mentioned hydrocarbon system lubricant with the fluoro alkyl group or the perfluoro polyether group is mentioned. As a perfluoro polyether group, a perfluoro methylene oxide polymer, They are perfluoro ethylene oxide polymer and perfluoro n-propylene oxide polymer $(CF_2CF_2CF_2O)_n$, perfluoro isopropanal pyreneoxide polymer $(CF(CF_3)\ CF_2O)_n$, or these copolymers. Specifically, the perfluoro methylene-perfluoro ethylenic copolymer (the AUSIMONT K.K. make, trade name FOMBLIN Z-DOL) etc. which have a hydroxyl group are mentioned to a molecular weight end.

[0036]As an extreme pressure additive, sulfur-systems extreme pressure agents, such as thiophosphite, such as phosphorous acid ester species, such as phosphoric ester, such as phosphoric acid TORIRAURIRU, and phosphorous acid TORIRAURIRU, and trilauryl trithiophosphite, thiophosphoric ester and dibenzyl disulfide, etc. are mentioned.

[0037]What is necessary is for the above-mentioned lubricant to be independent, or to be able to use together and use plurality, and to apply to the protective layer surface the solution which dissolved lubricant in the organic solvent with a spin coat method, the wire bar coat method, the gravure coating method, a dip coating method, etc., or just to make it adhere to the protective layer surface with a vacuum deposition method. As coverage of lubricant, 1 - 30 mg/m^2 is preferred, and especially 2 - 20 mg/m^2 is preferred.

[0038]In order to improve corrosion resistance further, it is preferred to use a rust-proofer together. As a rust-proofer, benzotriazol, a benzimidazole pudding, Nitrogen, sulfur content heterocycles, these derivatives, etc., such as a derivative which introduced the alkyl side chain etc. into nitrogen content heterocycles and these mother nuclei, such as pyrimidine, benzothiazole, 2-mercaptobenzothiazole, a TETORAZA indene ring compound, and a thiouracil compound, are mentioned. It may mix to lubricant and these rust-proofers may be applied on a protective layer, before they apply lubricant, they may be applied on a protective layer, and they may apply lubricant on it. As coverage of a rust-proofer, 0.1 - 10 mg/m^2 is preferred, and especially 0.5 - 5 mg/m^2 is preferred.

[0039]As for the field in which the magnetic layer of flexible polymeric support was formed, it is preferred to provide a back coat layer in the field of an opposite hand. When a magnetic recording medium and a slide member slide on a back coat layer, it has a lubrication effect which prevents wear of the back of a magnetic recording medium. Since lubricant and a rust-proofer are supplied to the magnetic layer side from the back coat layer side by adding lubricant and the rust-proofer which are used for a back coat layer at a lubricating layer, it becomes possible to hold the corrosion resistance of a

magnetic layer for a long period of time. The corrosion resistance of a magnetic layer can also be further improved by adjusting pH of the back coat layer itself. The back coat layer can produce nonmagnetic powder objects, such as carbon black, calcium carbonate, and alumina, and resin bond agents, such as polyvinyl chloride and polyurethane, and the solution which distributed lubricant and a hardening agent to the organic solvent further by applying and drying by the photogravure method, the wire bar method, etc. As a method of giving a rust-proofer and lubricant to a back coat layer, it may dissolve into the aforementioned solution and may apply to the produced back coat layer.

[0040]Next, the case where a magnetic recording medium is a flexible disk is explained. The base material of the flexible disk comprises a synthetic resin film provided with flexibility, i.e., flexible polymeric support, in order to avoid a shock when a magnetic head and a flexible disk contact. As such a synthetic resin film, aromatic polyimide, aromatic polyamide, Aromatic polyamidoimide, polyether ketone, polyether sulphone, The synthetic resin film which consists of polyether imide, polysulfone, a polyphenylene sulfide, polyethylenenaphthalate, polyethylene terephthalate, polycarbonate, triacetate cellulose, a fluoro-resin, etc. is mentioned. Since a good recording characteristic can be attained without heating a substrate in this invention, a substrate with good surface nature is obtained and especially polyethylene terephthalate or polyethylenenaphthalate with acquisition easy moreover is preferred.

[0041]What laminated two or more sheets for the synthetic resin film may be used as flexible polymeric support. By using the laminated film which laminated two or more sheets, the curvature and the wave resulting from the flexible polymeric support itself are mitigable. As a result, it cuts that the surface of a magnetic recording medium improves remarkably the damage resistance of a magnetic head and the magnetic layer by collision. The laminating method using the dry lamination which applies and laminates adhesives as a method of laminating a flexible film in the roll lamination by a hot calender roll, the monotonous lamination by monotonous heat pressing, and an adhesion side, and the adhesion sheet beforehand fabricated by the sheet shaped, etc. are mentioned. In using adhesives for lamination, using hot melt adhesive, thermosetting adhesive, a UV curing type adhesive, EB hardening type adhesives, a pressure sensitive adhesive sheet, anaerobic adhesive, etc. cuts.

[0042]10 micrometers - 200 micrometers of thickness [20 micrometers - 150 micrometers of] of flexible polymeric support are 30 micrometers - 100 micrometers still more preferably preferably. If the thickness of flexible polymeric support is thinner than 10 micrometers, the stability at the time of a high velocity revolution will fall, and field blur will increase. On the other hand, if the thickness of flexible polymeric support is thicker than 200 micrometers, the rigidity at the time of rotation becomes high, it will become difficult to avoid the shock at the time of contact, and it will cause the saltation of a magnetic head.

[0043]As for the nerve of flexible support, it is preferred that it is expressed with a following formula and the value in b= 10 mm is in the range of 0.5kgf/mm^2 - 2.0 kgf/mm^2 (**4.9 - 19.6MPa), 0.7kgf/mm^2 - 1.5 kgf/mm^2 (**6.9 - 14.7MPa) are more preferred. In nerve =$Ebd^3/12$ of a base material, in addition this formula, E expresses Young's modulus, b expresses film width, and d expresses film thickness respectively.

[0044]In order to perform record by a magnetic head, the thing smooth as much as possible of the surface of flexible polymeric support is preferred. Unevenness of a

support surface reduces the recording reproduction characteristics of a signal remarkably. Less than 1 micrometer of projected height which less than 5 nm of surface roughness measured with the light interference-type surface roughness plan measured with less than 2 nm and a sensing pin type roughness gauge preferably in the case where the under coat mentioned later is specifically used at the longitudinal-plane-of-symmetry average of roughness height SRa is less than 0.1 micrometer preferably. Less than 0.1 micrometer of projected height which less than 3 nm of surface roughness measured with the light interference-type surface roughness plan measured with less than 1 nm and a sensing pin type roughness gauge preferably in the case where an under coat film is not used at the longitudinal-plane-of-symmetry average of roughness height SRa is less than 0.06 micrometer preferably.

[0045]It is preferred to provide an under coat in the flexible Polymer Division support surface, in order to improve an improvement of smoothness and gas barrier properties. Since a magnetic layer is formed by sputtering etc., as for an under coat, excelling in heat resistance is preferred, and it can use polyimide resin, polyamide imide resin, silicone resin, a fluoro-resin, etc. as a material of an under coat, for example. Heat-hardened type polyimide resin and heat-hardened type silicone resin have an especially preferred flattening effect highly. As for the thickness of an under coat, 0.1 micrometer - 3.0 micrometers are preferred. When laminating other resin films to a base material, an under coat may be formed before lamination processing and an under coat may be formed after lamination processing.

[0046]The polyimide resin produced by carrying out thermal polymerization of the imide monomer which has two or more terminal unsaturated groups to intramolecular as thermosetting polyimide resin like screw ant Luna diimide (BANI by Maruzen Petrochemical Co., Ltd.) is used suitably. Since thermal polymerization of it can be comparatively carried out at low temperature after applying this imide monomer to a support surface in the state of a monomer, it can apply the monomer used as a raw material directly on a base material, and can stiffen it. A molecular weight is small, since that solution viscosity of this imide monomer is low, its surroundings lump which receives unevenness at the time of spreading is good, and its flattening effect is high [can use it, making it able to dissolve in a common organic solvent, and it is excellent in productivity and workability, and].

[0047]The silicone resin which polymerized in the sol gel process as thermosetting silicone resin by using as a raw material the silicon compound in which the organic group was introduced is used suitably. Since this silicone resin consists of structure which replaced a part of combination of the silica dioxide by the organic group, and is more nearly substantially [than silicone rubber] excellent in heat resistance and it excels a silica dioxide film in pliability, even if it forms a resin layer on the base material which consists of flexible films, neither a crack nor exfoliation produces it easily. Since the monomer used as a raw material can be directly applied on flexible polymeric support and can be stiffened, the surroundings lump which can use a general-purpose solvent and receives unevenness is also good, and a flattening effect is high. Since a polycondensation reaction advances from low temperature comparatively by addition of catalysts, such as acid and a chelating agent, it can be stiffened in a short time and can form a resin layer using a general-purpose coater. Thermosetting silicone resin has the high gas cover nature which covers the gas which is excellent in gas barrier properties,

occurs from flexible polymeric support at the time of magnetic layer formation, and checks the crystallinity of a magnetic layer or a foundation layer, and a stacking tendency, and it is especially preferred for it.
[0048]It is preferred to provide a minute projection (texture) for the purpose of reducing the real contact area of a magnetic head and a flexible disk, and improving a sliding characteristic on the surface of an under coat. The handling nature of flexible polymeric support also becomes good by providing a minute projection. Although the method of applying spherical silica particles, the method of applying an emulsion and forming the projection of an organic matter, etc. can be used as a method of forming a minute projection, in order to secure the heat resistance of an under coat, it is preferred to apply spherical silica particles and to form a minute projection.
[0049]As for the height of a minute projection, 5 nm - 60 nm are preferred, and its l0nm-30mm is more preferred. If the height of a minute projection is too high, the recording reproduction characteristics of a signal will deteriorate by the spacing loss of a record reproduction head and a medium, and if a minute projection is too low, the improvement effect of a sliding characteristic will decrease. The density of a minute projection has preferred 0.1-100 piece [/micrometer] ^{2}, and its 1-10 piece [/micrometer] ^{2} is more preferred. When there is too little density of a minute projection, the improvement effect of a sliding characteristic decreases, if too large, by the increase in floc, a high projection will increase and recording reproduction characteristics will deteriorate. A minute projection is also fixable to a support surface using a binder. It is preferred to use the resin which equipped the binder with sufficient heat resistance, and especially the thing for which solvent meltable type polyimide resin, heat-hardened type polyimide resin, and heat-hardened type silicon resin are used is preferred as resin provided with heat resistance.
[0050]In the lower layer of a magnetic layer, it is preferred to provide a foundation layer. Nitrides, such as amorphous materials, such as an alloy which makes a subject metal or these metal, such as Ti, Pt, Ru, and Pd, as a foundation layer, or C, Si, aluminum, and Ti, an oxide, etc. can be raised. Since the stacking tendency and granulation of a magnetic layer are improvable by using such a foundation layer, a recording characteristic improves. As for the thickness of a foundation layer, 10 nm - 200 nm are preferred, and 20 nm - especially 100 nm are preferred. Especially the thing in which the magnetic layer was formed pillar-shaped of the foundation layer is preferred. By being formed pillar-shaped, the isolation construction between ferromagnetic metal is stabilized, high coercive force is acquired, and high power becomes possible, and distribution of ferromagnetic metal will become uniform, and the magnetic recording medium of a low noise will be obtained.
[0051]Between a foundation layer and flexible polymeric support, in order to improve the adhesion and structure of a foundation layer, a seed layer can be provided. Ta, Ta-Si, nickel-P, nickel-aluminum, etc. can be used for a seed layer.
[0052]When performing the vertical magnetic memory by a single magnetic pole head, it is preferred to provide a soft magnetism layer between a magnetic layer and flexible polymeric support. A magnetic parametric performance can be improved by providing a soft magnetism layer. Materials, such as a permalloy and Sendust, can be used as soft magnetic materials. It is preferred that it is 30-200 nm as the thickness. In the lower layer of a magnetic layer, it is preferred to provide a foundation layer. An alloy with the metal

chosen from Cr or Cr and Ti, Si, W, Ta, Zr, Mo, Nb, etc. as a foundation layer, Ru, C, etc. can be mentioned.

[0053]A protective layer is provided on the surface of a magnetic layer. A protective layer prevents the corrosion of the metallic material included in a magnetic layer, prevents the false contact with a magnetic head and a magnetic disk, or wear by contact sliding, and it is provided in order to improve running durability and corrosion resistance. In a protective layer, silica, alumina, a titania, zirconia, cobalt oxide, Materials, such as carbon, such as carbide, such as nitrides, such as oxides, such as nickel oxide, titanium nitride, silicon nitride, and boron nitride, silicon carbide, chromium carbide, and boron carbide, graphite, and amorphous carbon, can be used.

[0054]It is a rigid film which is equivalent to magnetic head construction material, or has the hardness beyond it as a protective layer, and what the effect is stabilized and is maintained that it is hard to produce seizure during sliding is excellent in sliding durability, and preferred. What has a few pinhole is excellent in corrosion resistance, and simultaneously more preferred. The hard carbon film called the diamond like carbon (DLC) produced with a CVD method as such a protective film is mentioned. A protective layer can be considered as the composition which laminated two or more kinds of thin films in which character differs. For example, it becomes possible by providing the hard carbon protective film for improving a sliding characteristic in the surface side, and providing nitride protective films, such as silicon nitride for improving corrosion resistance to the magnetic layer side, to be compatible at a high dimension in corrosion resistance and endurance.

[0055]On a protective layer, in order to improve running durability and corrosion resistance, a lubricating layer is provided. Lubricant, such as hydrocarbon system lubricant, fluorine system lubricant, and an extreme pressure additive, is used for a lubricating layer. As hydrocarbon system lubricant, carboxylic acid, such as stearic acid and oleic acid. Sulfonic acid, such as ester species, such as butyl stearate, and octadecylsulfonic acid. Amines, such as carboxylic amide, such as alcohols, such as phosphoric ester, such as phosphoric acid monooctadecyl, stearyl alcohol, and oleyl alcohol, and octadecanamide, and stearylamine, etc. are mentioned.

[0056]As fluorine system lubricant, the lubricant which replaced a part or all of the alkyl group of the above-mentioned hydrocarbon system lubricant with the fluoro alkyl group or the perfluoro polyether group is mentioned. As a perfluoro polyether group, a perfluoro methylene oxide polymer, They are perfluoro ethylene oxide polymer and perfluoro n-propylene oxide polymer $(CF_2CF_2CF_2O)_n$, perfluoro isopropanal pyreneoxide polymer $(CF(CF_3)\ CF_2O)_n$, or these copolymers. Specifically, the perfluoro methylene-perfluoro ethylenic copolymer (the AUSIMONT K.K. make, trade name:FOMBLIN Z-DOL) etc. which have a hydroxyl group are mentioned to a molecular weight end.

[0057]As an extreme pressure additive, sulfur-systems extreme pressure agents, such as thiophosphite, such as phosphorous acid ester species, such as phosphoric ester, such as phosphoric acid TORIRAURIRU, and phosphorous acid TORIRAURIRU, and trilauryl trithiophosphite, thiophosphoric ester and dibenzyl disulfide, etc. are mentioned.

[0058]What is necessary is for the above-mentioned lubricant to be independent, or to be able to use together and use plurality, and to apply to the protective layer surface the solution which dissolved lubricant in the organic solvent with a spin coat method, the

wire bar coat method, the gravure coating method, a dip coating method, etc., or just to make it adhere to the protective layer surface with a vacuum deposition method. As coverage of lubricant, 1 - 30 mg/m^2 is preferred, and especially 2 - 20 mg/m^2 is preferred.
[0059]In order to improve corrosion resistance further, it is preferred to use a rust-proofer together. As a rust-proofer, benzotriazol, a benzimidazole pudding, Nitrogen, sulfur content heterocycles, these derivatives, etc., such as a derivative which introduced the alkyl side chain etc. into nitrogen content heterocycles and these mother nuclei, such as pyrimidine, benzothiazole, 2-mercaptobenzothiazole, a TETORAZA indene ring compound, and a thiouracil compound, are raised. It may mix to lubricant and these rust-proofers may be applied on a protective layer, before they apply lubricant, they may be applied on the protective layer 18, and they may apply lubricant on it. As coverage of a rust-proofer, 0.1 - 10 mg/m^2 is preferred, and especially 0.5 - 5 mg/m^2 is preferred.
[0060]When producing a hard disk, aluminum or its alloy, glass, carbon, polycarbonate, amorphous polyolefine, etc. can be used as a base material. Such materials are pierced, prepare what processed predetermined shape beforehand with techniques, such as molding, after they grind this surface mechanically or chemically and make it smooth enough, provide a texture if needed and make moderate surface roughness to it. In addition, when producing a hard disk, the art indicated with the above-mentioned tape or the flexible disk is applicable suitably.
[0061]The manufacturing method of the magnetic recording medium which used flexible polymeric support for below is explained. The formation method of the magnetic layer to the flexible polymeric support top using a film deposition system is explained. a film deposition system has a vacuum chamber and is a volume from a volume broth roll -- by a tension adjusting roll, the flexible polymeric support carried out has tension adjusted, and is sent to a membrane formation room. After the membrane formation room has been decompressed by the predetermined decompression degree with the vacuum pump, argon is supplied by the predetermined flow from the sputtering gas supplying pipe. Flexible polymeric support is in the state conveyed with with a volume by the membrane formation roll formed in the membrane formation room, and the atom for foundation layer formation jumps out of the target of a foundation layer sputtering system, and it is formed on flexible polymeric support.
[0062]Subsequently, in a membrane formation roll, from the ferromagnetic metal alloy with which the magnetic layer sputtering system was equipped, and the target which distributed the non-magnetic metal oxide uniformly, the atom for magnetic layer formation is emitted and a magnetic layer is formed on a foundation layer. Next, an opposite hand is formed with the field where the atom for foundation layer formation jumped out of the target of the foundation layer sputtering system, and the magnetic layer was formed in the point of flexible polymeric support in the state where it moved twisting around the 2nd membrane formation roll the field in which the magnetic layer was formed. From the ferromagnetic metal alloy with which the magnetic layer sputtering system was equipped on the membrane formation roll, and the target which distributed the non-magnetic metal oxide uniformly, the atom for magnetic layer formation is emitted and a magnetic layer is formed on a foundation layer.
[0063]A magnetic layer is formed in both sides of flexible polymeric support of the above process, and it is rolled round by a winding roll. Although the above explanation explained the method of forming a magnetic layer in both sides of flexible polymeric

support, it is also possible to form only in one field in a similar way. After forming a magnetic layer, protective layers including diamond like carbon are formed by a CVD method on a magnetic layer.

[0064]An example using high frequency plasma applicable to this invention of a CVD system is explained. The flexible polymeric support in which the magnetic layer was formed begins to be rolled from a roll, and runs in the state where electric power was supplied to bias voltage by the magnetic layer from bias power supply, and it was twisted around the membrane formation roll by the pass roller. On the other hand, nitrogen and the carbon protection film containing rare gas are formed on the metal thin film on a membrane formation roll of the plasma generated with the voltage impressed from the RF generator, and raw material gas containing hydrocarbon, nitrogen, rare gas, etc. is rolled round by the winding roll by it. Bigger adhesion is securable by defecating the magnetic film surface by rare gas, glow processing by hydrogen gas, etc. before production of a carbon protection film. Adhesion can be further improved by forming a silicon interlayer etc. in a magnetic layer surface.

[0065]

[Example]Working example and a comparative example are shown below and this invention is explained to it.

(Production of magnetic tape)

Working example 1-16.3 micrometers in thickness, surface roughness Ra = On a 1.2-nm polyethylene terephthalate film, 3-glycidoxypropyltrimetoxysilane, After applying the under coat liquid which consists of phenyltriethoxysilane, chloride, aluminum acetylacetonate, and ethanol by the gravure coating method, desiccation and hardening were performed at 100 ** and the under coat which consists of 0.2-micrometer-thick silicone resin was produced. the obtained under coat top -- silica with a particle diameter of 25 nm -- the coating liquid which mixed said under coat liquid with sol was applied by the gravure coating method, the 15-nm-high projection was formed by the density of ten piece [/micrometer] ^{2} on the under coat, and it was considered as the original fabric for magnetic tape.

[0066]Next, it conveys, equipping with the original fabric obtained by the web sputtering system, and sticking a film on the water-cooled membrane formation roll, The foundation layer which consists of Ti with DC magnetron sputtering method is formed by a thickness of 30 nm on an under coat, Then, the first magnetic layer of the presentation which consists of CoPtCr alloy (Co:Pt:Cr=70:20:10 atomic ratio):SiO_2=88:12 (metal atom ratio) is formed by a thickness of 20 nm, The second magnetic layer of the presentation which furthermore consists of $Tb_{18}Fe_{72}Co_{10}$ (atomic ratio) was formed by a thickness of 5 nm.

[0067]Equip a web-type CVD system with the original fabric in which the magnetic layer was formed, and Next, ethylene, The nitrogen addition diamond-like-carbon (DLC) protective film which consists of C:H:N=62:29:7 (mol ratio) with the RF plasma CVD method using nitrogen gas and argon gas as reactant gas was formed by a thickness of 10 nm. The bias voltage of -400V was impressed to the magnetic layer at this time.

[0068]With the field in which the magnetic layer of flexible polymeric support was formed, to the field of an opposite hand, next, carbon black, The back coat liquid which dissolved calcium carbonate, stearic acid, a nitrocellulose, polyurethane, and an isocyanate curing agent in methyl ethyl ketone, and was distributed was applied by the wire bar method, it dried at 100 **, and the 0.5-micrometer-thick back coat layer was

produced.
[0069]The solution which dissolved the perfluoro polyether system lubricant (FOMBLIN Z-DOL by AUSIMONT K.K.) which has a hydroxyl group in a molecular terminal in the fluorine system solvent (Sumitomo 3M HFE-7200) was applied to the protective layer surface by the gravure coating method, and the 1-nm-thick lubricating layer was formed in it.
[0070]Next, after judging the obtained original fabric in width of 8 mm, and carrying out tape polish of the surface, it included in the cartridge for 8-mm videocassettes, and magnetic tape was produced.
[0071]In one to comparative example 1 working example 1-1, the first magnetic layer and the second magnetic layer set the presentation of the magnetic layer to Co:Pt:Cr=70:20:10 (atomic ratio), and the point except having considered it as the total thickness of 25 nm produced magnetic tape like working example 1-1.
[0072]The first magnetic layer is set to Co:Pt:Cr=70:20:10 (atomic ratio) in one to comparative example 2 working example 1-1, Once having formed membranes as 150 ** and rolling round the temperature of the membrane formation roll at the time of forming a foundation layer and the first magnetic layer, the substrate was water-cooled and magnetic tape was produced like working example 1-1 except having formed the second magnetic layer.
[0073]In one to comparative example 3 working example 1-1, the thickness of the first magnetic layer was 25 nm, and magnetic tape was produced like working example 1-1 except not having formed the second magnetic layer.
[0074]The valuation method 1 which showed each obtained magnetic tape below estimates the characteristic, and the result is shown in Table 1.
[0075](Valuation method 1)
1. The coercive force Hc of the magnetic-properties perpendicular direction was measured with the sample oscillatory type magnetometer (VSM), and it was considered as magnetic properties.
2. The amount magnetic tape of cupping was cut in length of 100 mm, this was settled on the smooth glass plate, and measuring the tape width estimated modification of the tape width direction as an amount of cupping.
3. -- recording with a C/N inductive head and performing record reproduction of linear recording density 130kFCI using regenerative-track 2.2 micrometers in width, and the MR head of 0.26 micrometer of reproducing gaps -- a regenerative signal/noise (C/N) -- the ratio was measured. At this time, relative velocity of the tape/head was carried out in 10 m/sec, and the head load was taken as 29.4mN (3gf).
4. the still playback time of the time of the endurance videotape recorder of 8 mm performing still playback, and an output being set to -3dB of an initial value -- as endurance time -- a table -- the bottom. Measurement environment was set to 23 **10%RH, and the examination was made into a maximum of 24 hours.
5. It was kept by the environment of preservability of 60 ** 50%RH for 72 hours, and the signal output margin of decline before and behind storage was investigated.
[0076]
[Table 1]

表１

試料	Ｈｃ（ｋＡ／ｍ）	カッピング（ｍｍ）	Ｃ／Ｎ（ｄＢ）	耐久時間（ｈ）	保存性（ｄＢ）
実施例１－１	２２０	７．９	０	＞２４	－１．２
比較例１－１	１１５	７．９	－５．９	＞２４	－１．０
比較例１－２	１６５	６．８	測定不可	０．１	測定不可
比較例１－３	１８４	７．９	＋０．２	＞２４	－３．５

[0077]The above-mentioned result shows that the magnetic tape of this invention is excellent in a recording characteristic, endurance, and preservability. On the other hand, coercive force (Hc) declines and, as for the magnetic tape of the comparative example 1-1 which does not contain the non-magnetic metal oxide in a magnetic layer, the recording characteristic is falling. In the comparative example 2 which furthermore raised the forming temperature of a foundation layer and a magnetic layer, although coercive force has improved, the film of flexible polymeric support changed with heat, and endurance got worse remarkably. When microscope observation of the tape surface was carried out, the detailed crack had occurred in the magnetic layer. With the sample of the comparative example 1-3 which did not use a rare earth transition metal, the signal output after preservation was large and the influence of heat fluctuation appeared.

[0078](Production of a flexible disk hard disk)

Working example 2-163 micrometers in thickness, surface roughness Ra = On a 1.4-nm polyethylenenaphthalate film, 3-glycidoxypropyltrimetoxysilane, After applying the under coat liquid which consists of phenyltriethoxysilane, chloride, aluminum acetylacetonate, and ethanol by the gravure coating method, desiccation and hardening were performed at 100 ** and the under coat which consists of 1.0-micrometer-thick silicon resin was produced. this under coat top -- silica with a particle diameter of 25 nm -- the coating liquid which mixed said under coat liquid with sol was applied by the gravure coating method, and the 15-nm-high projection was formed by the density two of ten pieces/micrometer on the under coat. This under coat was formed in both sides of the flexible Polymer Division base film. The obtained flexible Polymer Division base film was made into the original fabric, and the sputtering system was equipped with it.

[0079]Next, it conveys, equipping with the original fabric obtained by the web sputtering system, and sticking a film on the water-cooled membrane formation roll, The foundation layer which consists of Ti with DC magnetron sputtering method is formed by a thickness of 30 nm on an under coat, Then, the first magnetic layer of the presentation which consists of CoPtCr alloy (Co:Pt:Cr=70:20:10 atomic ratio):SiO_2=88:12 (metal atom ratio) is formed by a thickness of 20 nm, The second magnetic layer of the presentation which furthermore consists of Tb18Fe72Co10 (atomic ratio) was formed by a thickness of 5 nm. This foundation layer and a magnetic layer formed membranes to both sides of the film. Next, the original fabric in which the magnetic layer was formed was installed in the web-type CVD system, and the protective film which consists of nitrogen addition diamond like carbon which consists of C:H:N=62:29:7 (mol ratio) with ethylene, nitrogen gas, and the RF plasma CVD method using argon as reactant gas was formed by a thickness of 10 nm. The bias voltage of -400V was impressed to the magnetic layer at this time. The protective layer also formed membranes to both sides of the film.

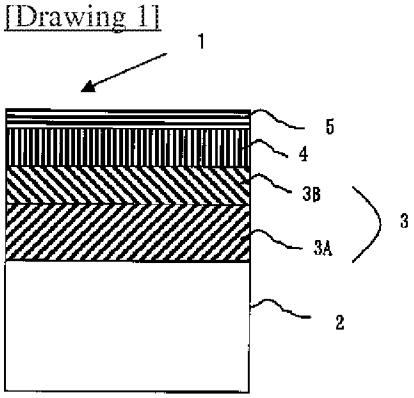
[0080]Next, the solution which dissolved the perfluoro polyether system lubricant (Montefluos FOMBLIN Z-DOL) which has a hydroxyl group in a molecular terminal in the fluorine system solvent (Sumitomo 3M HFE-7200) is applied to the double-sided protective layer surface by the gravure coating method, The 1-nm-thick lubricating layer was formed. After piercing in magnetic-disk shape 94 mm in diameter from the obtained original fabric and carrying out tape polish of this, it included in the cartridge made of a synthetic resin for flexible disks (for [by Fuji Photo Film Co., Ltd.] Zip100), and the flexible disk was produced.
[0081]Using the glass substrate with a diameter of 65 mm which carried out mirror polishing as a substrate in two to working example 2 working example 2-1, the foundation layer of the same presentation as working example 2-1 and the magnetic layer were formed in both sides using the batch type sputter device to this substrate, and the protective film was further formed with the CVD system. The same lubricating layer as working example 2-1 was formed with the dip coating method on this sheet. Tape polish of this was carried out and the hard disk was produced.
[0082]In two to comparative example 1 working example 2-1, the first magnetic layer and the second magnetic layer set the presentation of the magnetic layer to Co:Pt:Cr=70:20:10 (atomic ratio), and the point except having considered it as the total thickness of 25 nm produced the flexible disk like working example 2-1.
[0083]The first magnetic layer is set to Co:Pt:Cr=70:20:10 (atomic ratio) in two to comparative example 2 working example 2-1, Once having formed membranes as 150 ** and rolling round the temperature of the membrane formation roll at the time of forming a foundation layer and the first magnetic layer, the substrate was water-cooled and the flexible disk was produced like working example 2-1 except having formed the second magnetic layer.
[0084]The valuation method 2 which showed each obtained sample below estimates the characteristic, and the result is shown in Table 2.
(Valuation method 2)
1. The coercive force Hc of the magnetic-properties perpendicular direction was measured with the sample oscillatory type magnetometer (VSM), and it was considered as magnetic properties.
2. The field blur flexible disk and the hard disk were rotated at 3000 rpm, and field blur in a position 25 mm in radius was measured with the laser displacement gage from the center.
3. -- recording with a C/N inductive head and performing record reproduction of linear recording density 130kFCI using regenerative-track 2.2 micrometers in width, and the MR head of 0.26 micrometer of reproducing gaps -- a regenerative signal/noise (C/N) -- the ratio was measured. At this time, number of rotations was provided in radius of 3000 rpm, the head was provided in 35 mm in radius, and it measured. The head load was taken as 29.4mN (3gf).
4. The reproducing output in the case of modulation aforementioned C/N measurement was measured about a disk round, and the ratio to the maximum of the minimum of this output was expressed with 100 molar fractions.
5. It was made to run, having repeated record reproduction and performing a flexible disk excluding an endurance hard disk by the drive for flexible disks (drive for Fuji Photo Film Co., Ltd. make Zip100), when the output was set to initial value-3dB, the run was

stopped, and it was considered as endurance time. Environment was set to 23 **50%RH and the examination was made into a maximum of 300 hours.
6. It was kept by the environment of preservability of 60 ** 50%RH for 72 hours, and the signal output margin of decline before and behind storage was investigated.
[0085]
[Table 2]
表２

試料	Ｈｃ（ｋＡ／ｍ）	面ぶれ（μｍ）	Ｃ／Ｎ（ｄＢ）	モジュレーション（％）	耐久時間（ｈ）	保存性（ｄＢ）
実施例２－１	２１０	３５	０	９５	＞３００	－１．０
実施例２－２	２２１	＜１０	－１．５	９８	評価せず	－０．８
比較例２－１	１０５	３５	－７．６	９２	＞３００	－１．８
比較例２－２	１８５	８０	－６．２	４８	＜１	－１．５

[0086]It turns out that the flexible disk of this invention is excellent in a recording characteristic, endurance, and preservability so that the above-mentioned result may show. In working example 2-2 which used the glass substrate for the substrate, C/N is falling a little to working example 2-1 which is a flexible disk. This is because the output is declining relatively, and since the flying height of a head is higher than a flexible disk, the direction of a hard disk is considered. In the comparative example 2-1 which did not use a non-magnetic metal oxide (SiO_2) for the magnetic layer, coercive force declines and the recording characteristic is falling. In the comparative example 2-2 which furthermore raised the forming temperature of a foundation layer and a magnetic layer, although coercive force has improved, the flexible Polymer Division base film changed with heat, and field blur and endurance got worse.
[0087]
[Effect of the Invention]This invention is a magnetic recording medium useful to magnetic tape, a flexible disk, etc. which can be used as a removable type magnetic recording medium, and can provide cheaply the perpendicular magnetic recording medium in which high density recording is possible.
DRAWINGS

[Drawing 1]



[Translation done.]